Forest Health Protection

Report 04-4 February 2004

Corps of Discovery Campground Hazard Tree Evaluation December 2003

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SUMMARY

In December 2003, trees near camping sites, campground trails and roads and other planned developed features of the Corps of Discovery Campground (formerly Lolo Cr. Campground) were mapped and scored for damage, defect and hazard. This hazard tree evaluation was completed in preparation for renovation and expansion of the campground. Twelve planned camping units, a day-use area, two parking areas and a trail were examined. Two hundred fifteen trees were mapped, only one of which was dead. The forest in and around the campground was mostly mature western redcedar and grand fir.

Many of the grand fir had signs of advanced heartrot caused by Indian paint fungus (*Echinodontium tinctorium*). A few grand firs also had advanced root disease. Cedar decline was common with most trees having mild to moderate crown symptoms. Monitoring or removal was recommended for trees according to the severity of their damage or defect, likelihood that a damage or defect may lead to tree failure, and probability that a failed tree or part of tree would strike a structure or an occupied site.

Removal was recommended for 32 trees, all grand fir. They ranged from less than 8.3 inches d.b.h. to 29.3 inches. Most had extensive heartrot. Cedar decline was the basis for most of the 19 trees recommended for monitoring.

A yearly walk-through exam is recommended for this campground with another full assessment in 5 years. The maps and database we developed

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in this assessment should make re-assessment of these trees relatively easy. A vegetation management plan that emphasizes maintaining the cedar component is recommended. Tree replacement objectives may be accomplished by managing advanced regeneration present on the site.

General condition of trees in the campground

Corps of Discovery Campground, formerly Lolo Creek Campground, is located near the junction of Lolo and El Dorado creeks on the 100 road, Lochsa Ranger District, Clearwater National Forest. The portion of the campground previously developed at Lolo Cr. Campground will be expanded to provide additional camping sites as well as parking for a walk-in site and day-use area on Lolo Cr. This part of the new Corps of Discovery Campground is designated the Lewis Loop. Clark Loop will be developed in an area along El Dorado Creek that previously was used as an undeveloped group camping area.

Late seral cover types with roughly 40% western redcedar and 60% grand fir in the overstory dominate both portions of the campground. Grand fir, cedar, and occasional Engelmann spruce and Pacific yew make up the understory. Cedar decline is common and fairly advanced in some areas of the campground. Stem decay caused mostly by Indian paint fungus (*Echinodontium tinctorium)* is also common throughout the campground, particularly along the trail (see map in figure 1). Conks were the primary evidence of this disease observed. Annosus root disease *(Heterobasidion annosum)* was seen in several units of Lewis Loop but not recorded in Clark Loop. Fir engraver beetles (*Scolytus ventralis)* and annosus root disease *(Heterobasidion annosum)* were implicated in the death of one large diameter grand fir at the west end of the trail in Lewis Loop. Fir engraver was also the apparent cause of topkill of a large grand fir near unit 3.

Tree failure appears to be uncommon in and around the campground. Failure and standing mortality appeared to be restricted to grand fir, at least in the past few years.

Cedar decline is a common affliction of mature cedar in northern Idaho but the causes are poorly understood (See appendix A). Rood decay and extensive lesions extending up from roots on the lower stem are observed. Several root pathogens have been isolated from diseased roots, primarily *Armillaria ostoyae, Heterobasidion annosum and Phellinus weirii*.

Decay fungi typically work slowly. Stem decay generally starts with infections established in small shade-killed branches of understroy trees. These infections usually require decades to produce significant columns of decay. Similarly, root decay is a gradual process and trees may survive decades after infection, especially large trees. For further discussion of heartrot and root pathogen biology and management, see appendix A.

Monitoring and removal of trees identified as potential hazards will minimize the probability of a tree failure leading to personal injury or property damage in Jerry Johnson Campground. To this end we tried to make this initial assessment as thorough as possible, providing a database and maps to expedite future re-evaluations of the trees.

ASSESSMENT METHODS

We assessed the condition of all trees greater than 5 inches at breast height that were close enough to planned developed features of the campground to cause damage if they failed. The height of trees, projected to the ground, represented their potential hazard range.

We concentrated on the trees around future developed sites and campground roads. We examined all trees within striking distance of the proposed trail along Lolo Creek between sites 8 and 9 but we only mapped the locations of the few trees tagged for removal. We did not evaluate trees along the road connecting Lewis and Clark Loops of the campground.

Mapping and scoring trees

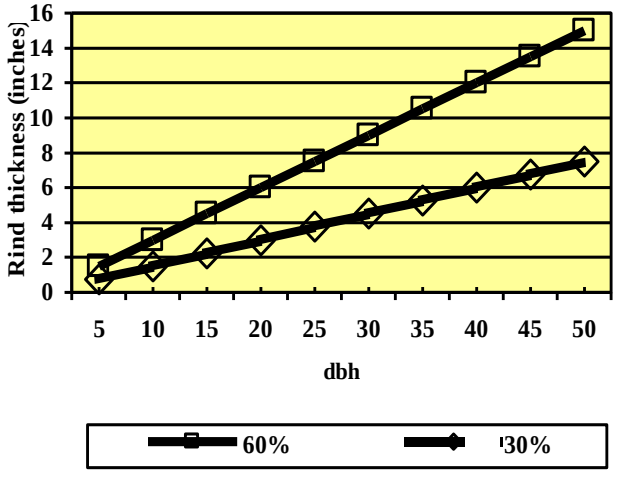
Where present, the fire ring was used as the map center for each site. The West Parking map lacked a fire ring or other permanent feature, so the trees are mapped with respect to each other and a cattle guard that will likely be removed

during construction. The map for the trail between units 8 and 9 centered on the existing vault toilet. Units 10 through 14 are included on one map with a large cedar tree (#14) as the plot center. All trees within target distance of any developed feature of the site were mapped and scored. Map blanks were used which divided the site into quadrants beginning with true north aspect and proceeding clockwise around the fire ring, or other central map feature.

Species and diameter at breast height was recorded for each tree. They were scored for all significant damages and defects observed using six standard damage categories (appendix B); decay, wound, canker, lean or sweep, branch or forking defects, root damage or disease. For each of these categories a severity range of 1-4 was applied, to make a combined code such as D3 (decay, severity level 3).

Where heartwood decay was suspected, trees were bored to determine the depth of sound rind. Trees with sound rind (outer xylem of the stem) depth of at least 60% of the radius of the stem are considered to be low hazard for failure due to the heartwood decay. Those with 60% to 30% sound rind are considered moderate hazard, and those with less than 30% have a relatively high probability of failure. Therefore, we used the graph in figure 1 to determine the severity rating for trees with heartrot.

Figure 1. Thickness of sound rind based on 30% and 60% of radius (inside bark).



Root damage ratings were used to indicate trees with root disease symptoms. A rating of R3 indicated trees with significantly deteriorated crown condition, presumably due to root disease. R4 indicated trees that were in the final stages of dying from root disease. Root damage ratings of 1 and 2 were used to indicate physical damages (wounding and severing).

Wounds, largely human-caused, were common in some sites. Multiple tops were common in cedars. Wounds, leans and multiple tops were scored according to the table in appendix B.

Cedar decline severity was based on the percent loss of crown: A rating of 1 indicating 10% crown loss, 2 meaning 20% loss, and so on. A unique feature of cedar decline is the loss of foliage being most severe at the tops of trees, with spike tops often resulting.

Determining targets

Many trees had more than one potential target. Standard target codes were as follows: 1 = occasional use such as trails or signs with no vehicle access (this code was not used in this assessment); 2 = intermittent use such as busy trails, the campground road and entry and day use areas; 3 = frequent use such as campsites, parking areas and permanent structures. Trees with more than one target were assigned the highest code applicable. The exception was in the case of a lean value of 3 or higher. If the tree was leaning strongly away from the highest rated potential target, it was assigned the rating of the more likely target.

Action recommendations

The damage threshold for western redcedar is much higher than that for grand fir. Cedar trees can withstand considerably more root decay and butt or heartrot that grand fir before physical failure or standing mortality occurs. These differences are reflected in the frequency and type of action recommendations for cedar and grand fir. Cedar trees with relatively advanced decline symptoms were designated for monitoring rather than removal.

Several grand fir trees with advanced root disease or heartrot symptoms or signs, especially those near or leaning toward

developed targets were designated for removal. Recommendation for removal was usually based on the probability of eminent death due to root disease or an unreasonably high probability of failure due to advanced heartrot or butt rot. A combination of moderate root disease and a lean toward a class 3 target, root disease combined with moderate heartrot (and a class 3 target) or similar combinations of conditions resulted in a recommendation for removal. Trees thus identified were tagged with metal numbered tags at breast height facing the map reference point. Nails used to attach tags were aluminum to ensure there would be no risk of saw or planer damage should the nail fail to be removed before falling or milling. We also flagged each tree recommended for removal to make them easy to spot.

Data handling

Data were recorded on field sheets and entered into a Microsoft Excel sheet for analysis using Microsoft Access. Maps were converted from hand-drawn maps to slides in a Microsoft PowerPoint presentation. Hand-drawn maps were electronically scanned to retain relative positions of trees around fire rings and standard mapping symbols were added as location markers for each tree with color-coding for easy reading (figure 2). Both the database and maps should be easily updated from these products for future assessments of Corps of Discovery. If kept current, they should provide easy tracking of campground trees in the future.

Although we worked from the blueprints of the approved campground renovation plan, official designations had not yet been assigned to the units. Therefore, we assigned tentative numbers to planned units 2-14, the east and west-end parking areas (designated 1 and 21, respectively) and the stand along the trail between units 8 and 9 (designated 22). The map number can be used to assure a correct match between the original unit numbers and numbers assigned in Access.

RESULTS OF THE ASSESSMENT

We assessed 208 trees in 12 campsites in both loops and the planned parking areas of Lewis

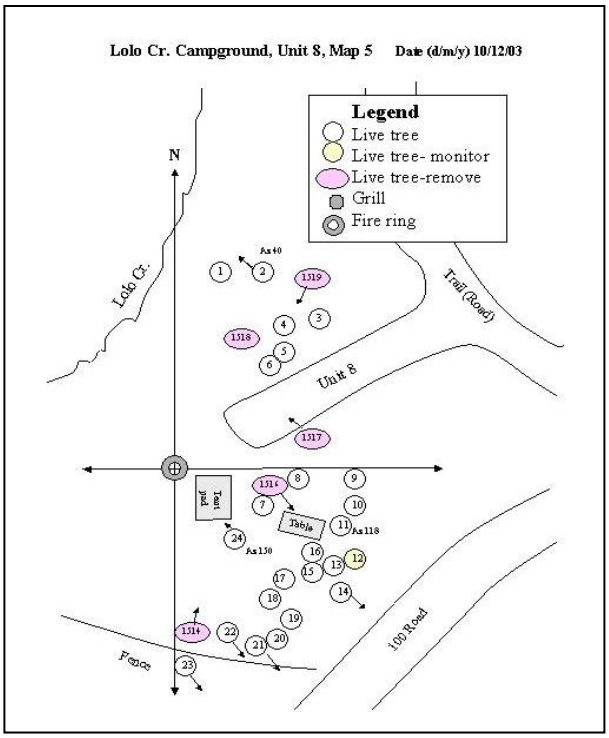


Figure 2. Example of unit maps stored in Microsoft PowerPoint

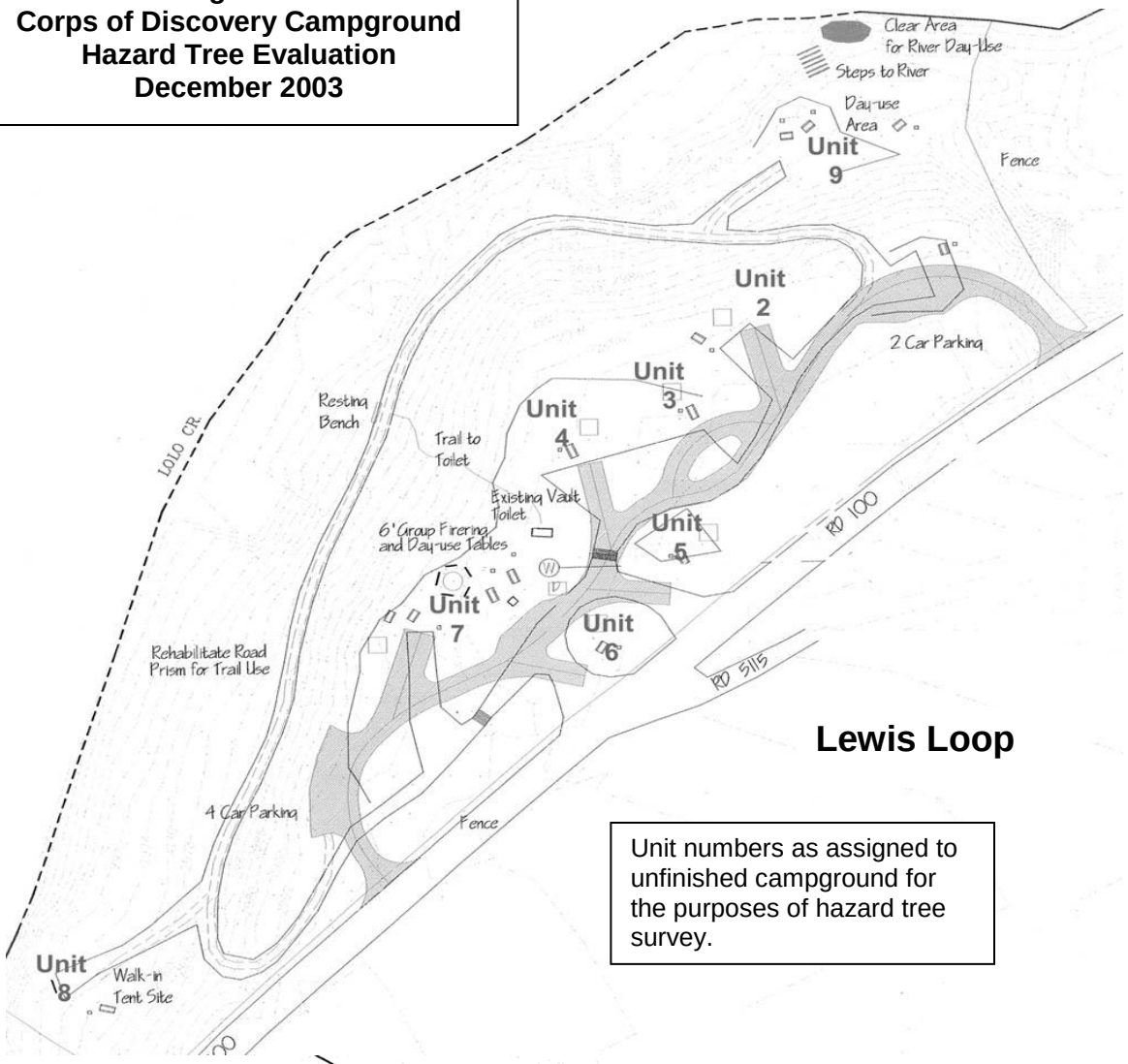
Loop. Units we designated 2 - 9 were in Lewis Loop and Units 10 through 14 were in Clark Loop (figure 3). Grand fir was the most numerous species (table 1), constituting 57% of the trees.

However, western redcedar, which constituted 40% of trees, tended to be much larger than the grand fir. This gave the impression of a cedar-dominated stand. A few Engelmann spruce and subalpine fir were present, particularly in Clark Loop.

Table 1. Tree condition and average diameter at breast height by species. (Based on December 2003 assessment.)

Species	Total	Dead	Average d.b.h.
Grand fir	122	1	17.2
Western redcedar	86	0	25.8
Engelmann Spruce	6	0	17.4
Subalpine fir	1	0	10.7
All species	215	1	

Figure 3
Corps of Discovery Campground
Hazard Tree Evaluation
December 2003



Tree damages and defects

The grand fir were mostly mature and many have multiple Indian paint fungus conks throughout the length of their boles. Of 121 live grand fir, 23% had decay ratings of 3 or 4, indicative of 60% or less solid rind (table 2). Failure rate for these grand fir is likely to increase slowly in the future as the developing decay columns weaken the stems. Grand fir growing in the understory can be expected to also have high rates of stem decay when they reach maturity owing to current stand conditions which favor *E. tinctorium* infection and decay development. The high level of human-caused wounding in some of the sites undoubtedly will contribute greatly to increased decay rates. Cambial wounds are known to increase frequency and extent of stem decay within a few decades of wounding (Aho and Filip 1982).

Table 2. Moderate to severe damages or defects observed on live trees with target codes 2 or greater. (Based on December 2003 assessment.)

Species	Total live	Stem Decay		Wounds		Double or broken tops		Root Disease	Cedar Decline
		Sev 3	Sev 4	Sev 3	Sev 4	Sev 3	Sev 4	Sev 3+	Sev 5+
Grand fir	121	21	7	11	1	2	3	6	--
Western redcedar	86	9	1	7	0	3	9	11	19
Engelmann spruce	6	0	0	0	0	0	0	0	--
Subalpine fir	1	0	0	0	0	0	0	0	--
All species	214	30	8	16	1	5	12	17	19

Both root disease and associated bark beetles are currently minor influences in grand fir here. The west parking area, and units 2 and 3 have evidence of some annosus root disease mortality (table 3). The disease is likely to continue to spread slowly in both locations and could appear in others eventually, especially with disturbance resulting from campground renovation.

Cedar decline, which appears to be primarily a root disease-caused symptom, was common in both loops of the campground. The highest rating assigned for cedar decline in Corps of Discovery Campground was 6 or 60% crown loss. A total of 19 trees (22% of cedars) had the relatively high ratings of 5 or 6. The high-rated cedars were mostly clustered in a few sites in both loops. Units 2 through 5 in Lewis loop and 10, 12 and 13 in Clark Loop had the highest frequencies of decline.

Stand of trees along the trail

Most of the trees along this trail are mature grand fir. Six trees were identified for removal along the trail between units 8 and 9. Those tagged for removal were grand fir with either severe stem decay or severe root disease, or both. Even a primary trail has a target class of only 2 because there is little likelihood that a failing tree will cause injury or damage. Therefore, we tagged only those trees with the most advanced symptoms and did not take time to map all trees that could have impacted the trail. We mapped three areas along the trail to indicate the need to monitor trees fairly closely because stem decay in grand fir is prevalent and will probably lead to additional tree failures (figure 4).

Table 3. Severe damage codes assigned to live trees by unit. (Based on December 2003 assessment.

						Recommended Action		
Unit	Total live	Stem Decay	Wounds	Root Disease	Cedar Decline	Monitor	Remove	
		Sev 3+	Sev 3+	Sev 3+	Sev 5+		Trees	Percent
East Parking	23	4	7	0	0	0	2	8.7
2 & 3	13	0	0	3	4	4	1	7.7
4 & 5	23	1	6	6	4	4	2	8.1
6	3	2	1	1	0	0	0	0
7	17	2	1	2	0	0	4	23.5
8	29	5	6	0	0	1	5	17.2
9	34	6	8	3	1	2	6	17.6
West Parking	15	3	0	2	0	0	3	20.0
Trail	--	6	0	2	--	--	6	--
10	23	3	2	1	2	2	0	0
11	4	0	0	0	0	0	0	0
12	13	2	2	1	5	5	1	7.7
13	12	4	2	1	3	3	2	16.7
14	4	0	0	0	0	0	0	0
All Units	214	38	35	22	19	21	32	15.0

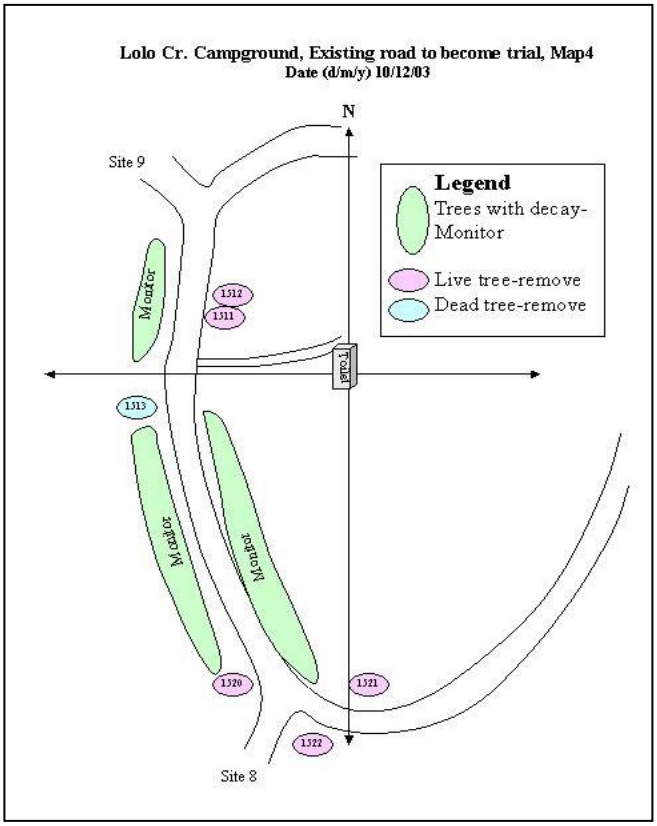


Figure 4. Map of trail between units 8 and 9. Areas designated for monitoring and location of trees recommended for removal.

RECOMMENDED ACTIONS

Only grand fir was recommended for removal. There were 32 trees tagged for removal and two others that we recommended be monitored in addition to trees in the shaded areas in figure 4 along the trail.

Overall, we recommended removal at this time for 23% of the 122 grand fir we evaluated—15% of the trees evaluated (table 4). Most of the recommended removals were in units 7-9, the west parking area and along the trail (table 3). In other units, no trees, or only one or two were tagged for removal.

Table 6. Number of recommended removals by diameter class.
(Based on December 2003 assessment.)

	Diameter classes (inches at breast height)							
Species	8-11.9	12-15.9	16-19.9	20-23.9	24-27.9	>28	Max d.b.h.	Total
Grand fir	4	5	11	7	3	2	29.3	32

Trees recommended for removal ranged from 8.3 inches to 29.3 inches d.b.h. Table 6 provides a breakdown of recommended removals by species and diameter classes. Of the 32 trees recommended to remove, 72% are at least 16 inches d.b.h. and all are grand fir.

Most target codes assigned were in the highest class, 3 (table 4). These were primarily the campsites themselves, including tent pads, tables, fire rings, and parking areas for the units. Of 215 trees evaluated, 90% were considered to have class 3 targets and as a result, 81% of recommended removals are in class 3 target locations.

Table 4. Recommended actions by target code.
(Based on December 2003 assessment.)

		Recommended Action	
Target Code	Total trees	Monitor	Remove
1	1	0	0
2	21	3	6
3	193	18	26
All	215	21	32

We noted a need to monitor 19 of the 86 (22%) of western redcedar trees because they have fairly advanced symptoms of cedar decline with 50 to 60 percent loss of crown (table 5). It is as yet unclear how often such decline leads to failure or death of afflicted trees, and how long that end may be in coming.

We do know that root infections lead to enlarging basal lesions and columns of butt heartwood decay. While both conditions weaken trees structurally, little resulting failure has been indicated to date. Studies underway on the Clearwater National Forest may provide answers to some of these questions in the near future. In the meantime, the trees should be monitored and their decline ratings updated as necessary.

Table 6. Cedar recommended for monitoring by diameter class and reason for recommendation.
(Based on December 2003 assessment.)

	Diameter classes (inches at breast height)				
Reason	14-19.9	20-29.9	30-39.9	40 +	Total
Decline (5+)	2	5	2		9
Decline (5+) and decay		1	3	1	5
Decline (5+) and wounds		1	1	1	3
Decline (5+) and leaning		1			1
Decline (5+), decay, and leaning		1			1
All causes	2	9	6	1	19

MANAGEMENT RECOMMENDATIONS

Removal of highest hazard trees before campground is occupied

These trees were mostly grand fir that, if they failed, would have tent or parking sites, tables, or fire pits as likely targets. They are trees that lean, show root heaving, or have heaviest crowns in the direction of one of these targets. Such trees have higher risk of causing property damage or injury in the case of failure. All trees have some risk of failure and trees with root disease are at an increased risk because of decay of structural roots. It is common practice in campground maintenance to remove trees with indicators of hazard (such as root disease or stem decay) with priority given to trees with human-inhabited targets.

Additional mortality should be anticipated as the disease continues to progress in remaining grand fir. Thinning will not improve the condition of grand fir trees and few are likely to survive more than one or two more decades. Annual evaluation of the site and removal of dead or dying trees is likely to be required. Revegetation with species resistant to S-type annosus and Armillaria root diseases will be necessary to re-establish tree cover and restore aesthetic qualities of the site.

Monitoring of all trees

A walk-through exam including reassessment of trees previously noted as needing monitoring should be done each year. A thorough assessment should occur about every 5 years, at which time the database and maps should be updated. Conditions are not expected to change rapidly in this campground although we can anticipate some amount of mortality, particularly grand fir, following disturbances related to campground renovation.

A vegetation management plan

A comprehensive vegetation management plan should be developed for this campground. Cedar and Engelmann spruce regeneration should be favored over grand fir to eventually minimize the impact of heartrot-caused Indian paint fungus. Root disease is present, and may expand in response to hazard tree removal and tree removals necessitated by campground renovation. Douglas-fir, grand fir and subalpine fir are highly susceptible (particularly Douglas-fir) and should be minimized in target vegetation. Western redcedar, western white pine and western larch are resistant (though not immune) to most root pathogens and are likely suitable species for this site. Native hardwood trees and shrubs are immune to annosus root disease.

As the mature cedar component continues to decline, provisions should be made for their replacement. This process is expected to be very slow but with as little as we know about the syndrome, it will bear watching. At our current stage of knowledge, we still recommend cedar as a highly desirable campground tree, in part because of its ability to withstand abuse.

Cedar can be expected to reproduce naturally as well as grand fir and Engelmann spruce. White pine and, perhaps western larch are also good choices for regeneration, but would undoubtedly require planting and tending.

Hardwoods such as mountain maple and serviceberry are immune to common root diseases of conifers.

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APPENDIX A

Annosus root disease biology and management

There are two types of *Heterobasidion annosum* in Idaho that are distinguished on the basis of host range. The P-type, which causes its greatest damage in ponderosa pine, appears to be far less common in Idaho than the S-type. S-type, named for it's significance as a pathogen of spruce species in Europe, is a very common and damaging pathogen of Douglas-fir, grand fir and subalpine fir in Idaho. Western redcedar is also a common host to *H. annosum*, though it seems to survive infections for many decades. Although we have not determined whether western redcedar is host to P-type or S-type, it is most likely to be S-type based the presence of root disease in Douglas-fir and grand fir growing in association with infected cedar. Pines, western larch and hardwoods are resistant to S-type *H. annosum*.

The disease, as the name implies, mostly involves the roots. The fungus attacks the root cambium, girdling and killing roots. Once dead, *H. annosum* decays roots. The disease spreads throughout root systems and the fungus moves from tree to tree through root contacts and for short distances through soil or duff. In general, the disease kills Douglas-fir more rapidly than grand or subalpine firs. Thus, by the time grand or subalpine firs are visibly declining, the Douglas-fir component of stands has already been killed. Once established on a site the fungus is essentially a permanent feature. They are long-lived organisms that can take advantage of the presence of hosts from one generation of trees to the next. They survive forest fires by slowly decaying root systems well below ground.

Stump surface infection can be an important means of spread of P-type annosum so management recommendations often include treatment of stump surfaces to prevent spread of the disease. S-type annosum does not provide

this opportunity. High rates of root infection exist in most Douglas-fir and grand fir stands that render stump infection inconsequential. Partial harvest, leaving Douglas-fir, grand fir or subalpine fir is discouraged because high rates of mortality of leave trees generally result. Mortality rates between 3% and 7% per year are common if apparently healthy Douglas-fir and true firs are left after harvest. (Rates are higher if symptomatic trees are left.)

Stem decay biology and management

Indian paint fungus, *Echinodontium tinctorium* and the white pocket rot, *Phellinus pini*, are thought to have similar biology. Infections are initially established in shade-killed branches. The fungus produces a "quiescent" infection in which it fails to progress much beyond the original point of establishment for some years. As the tree grows, the dead, infected branch stub is incorporated in the heartwood. Once surrounded by the no longer living, thereby no longer resistant, heartwood, the fungus begins to grow. It lives entirely by decaying dead heartwood, never invading live sapwood.

Decay caused by *E. tinctorium* can be especially extensive. A single young *E. tinctorium* conk may indicate a decay column extending 8 feet above and 8 feet below the conk. Larger, older conks may indicate 20 feet below and 21 feet above the conk. Two or more conks, widely separated on the stem, probably indicate that virtually the full length of the stem has a central column of decay. The longer the column is, the greater the width of the decay column. *Phellinus pini* decay is generally considered more limited in extent, extending about 3 feet in either direction from a conk. However, there are often many conks scattered throughout the length of the stem.

Wounds that kill a patch of cambium are known to greatly accelerate the extent and perhaps the rate of decay caused by Indian paint fungus. It is thought the dead tissue, which essentially becomes a part of the heartwood by virtue of being dead, increases aeration of the heartwood and improves growing conditions for the fungus.

Whatever the cause, wounds are a highly significant factor in predicting decay volumes in grand fir. Infected overstory grand fir with stagnated understory grand fir provides the ideal situation for development of Indian paint fungus infection.

Cedar decline

Cedar decline appears to be a widespread phenomenon in northern Idaho and parts of western Montana. The progress of the decline and eventual outcome is unknown. It appears that spike tops are commonly formed and that trees may live for many decades in advanced stages of decline. The cause or causes are also largely unknown.

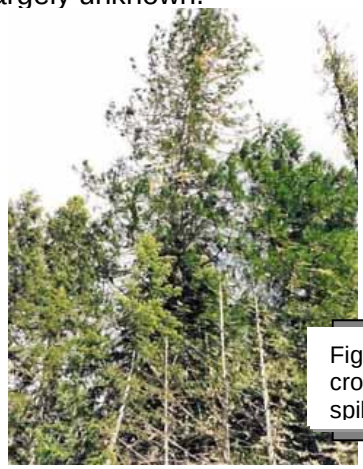

Figure 1. Cedar decline crowns are thin at top; spike tops are common.

Efforts are underway to map the extent and relative severity of and to determine the cause or causes of the decline

Severe root decay and girdling of root crowns has been found in association with advanced crown symptoms of decline. Girdling rates of 70% to 80% are common in living cedars. Two common root pathogens, *Armillaria* (probably *ostoyae*), and *Heterobasidion annosum* were consistently isolated pathogens in some locations. *Phellinus weirii* was the nearly exclusive pathogen isolated from a relatively undisturbed site with advanced decline symptoms.

Tree age, disturbance by tree cutting or burning, site factors such as soil type, and weather influences such as drought are all considered suspected factors in driving the cedar decline syndrome

APPENDIX B

INSTRUCTIONS: Find the description of defect that most closely describes an observed situation and enter the severity code on the evaluation form. If three or more defects of the same severity are recorded for a single tree (e.g., 3D, 3W, 3L), the overall severity rating for the tree may be increased by one level (column A on the evaluation form). Your situation may not be described or exactly fit a description; the descriptions are simply provided to assist you in assigning an appropriate severity level for each defect. **Dead trees are automatically assigned a severity of 4.**

SEV. CODE	
	DECAY OR CAVITY: trees where significant decay is suspected should be increment bored to determine sound wood remaining (Rind) and excluding bark; severity may be influenced by tree
1D	Staining, including wet wood, or incipient decay, but no advanced decay or fruiting bodies, no cavities.
2D	Advanced decay or cavities observed; sound wood (rind) >60% of radius; may have unusual pitch or watery slime seeping from cracks or openings.
3D	Advanced decay or cavities observed; sound wood (rind) 60-30% of radius (excluding bark); fruiting bodies may be present.
4D	Advanced decay or cavities observed; sound wood (rind) < 30% of radius; numerous conks or fruiting bodies or other defects.
	STEM DAMAGE AND WOUNDS: Lightning, frost cracks, mechanical, animal, human
1W	Cracks or wounds of any size but well-calloused or superficial, no decay
2W	Minor structural damage involving <10% of circumference; small cracks, fire scars.
3W	Some structural damage and associated decay; 10-50% circumference; large fire scars; severe cracks extending through stem.
4W	Multiple cracks or wounds causing severe structural damage and associated decay in > 50% of circumference; or movement detected in major crack.
	CANKERS: Blister rust, gall rust, dwarf mistletoe, etc.
1C	< 10% of bole girdled; burls of any size
2C	10-30% of bole girdled
3C	30-75% of bole girdled
4C	>75% of bole girdled or associated with other defects.
	LEAN/SWEEP: growth at the very top of the tree may indicate how long a tree has been leaning.
1L	Natural long-term lean <10%, fully compensated by growth (top of tree is vertical for many years).
2L	Natural long-term lean 10-15 degrees, fully compensated by growth (top of tree is vertical for many
3L	Lean 15-20 degrees or some indication of root movement (soil mounding, etc.), or associated with
4L	Lean >20 degrees with evidence of failure (e.g., obvious recent soil movement, root wrenching); associated with decay or cracks.
	BRANCHES, FORKS, WITCHES BROOMS AND TOPS
1B	Small dead or hanging branches or dead top <"; small witches brooms.
2B	Large brooms, dead or hanging branches or dead top 3-5"; unbalanced canopy due to poor pruning or multiple tops; codominant stems with no included bark.
3B	Dead or broken branches or dead top 6-9"; large codominant stems with included bark (weak
4B	Dead or broken branches or dead top >9".
	ROOT DAMAGE, ROOT DISEASE
1R	Minor exposed roots, not sprung, no decay
2R	Exposed roots with minor damage or decay on small roots (<3"); no evidence of root disease.
3R	Substantial damage to roots >3" but <50% or root system affected; root disease suspected (slow growth, or other symptoms) but not obvious or confirmed.
4R	Exposed, decayed roots or substantial damage to roots >3" on >50% of root system; obvious root disease symptoms or signs (e.g., thinning, fading crown, stress cone crop, basal resinosus).